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Effect of storage on composition, physico-chemical, rheology, sensory and microbiological quality of Indian cookie *Rava Burfi*

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Abstract: In the present study, changes in compositional, physico-chemical, rheological, sensory and microbial properties (SPC, coliform count and yeast and mould count) of *rava burfi* packed in composite polyethylene terephthalate (PET)/low density polyethylene (LDPE) film was monitored during storage at room temperature (30± 2 °C) and refrigerated temperature (7±2 °C) on every 3rd for room temperature and on every 7th day for refrigerated temperature of storage till the products became unacceptable. All the changes related to composition, acidity, water activity, Free Fatty Acid (FFA), soluble nitrogen, 5-Hydroxy Methyl Furfural (HMF) and Thiobarbituric Acid (TBA), rheological, sensory and microbiological properties of *rava burfi* were found to be significantly (P<0.05) affected by storage period (i.e. 9 days at room temperature (30±2 °C) and 35 days at refrigerated (7±2°C) temperature). During storage period there was a decrease in moisture content (2.5 to 3.0%) and water activity and an increase in fat, protein, lactose, ash, added sugar, acidity, FFA, soluble nitrogen, TBA and HMF both at ambient (30±2 °C) as well as at refrigerated (7±2°C) temperature. Changes in rheological attributes at both ambient and refrigerated temperatures of storage indicated that there was an increase in hardness, gumminess, chewiness and adhesiveness whereas there was decrease in cohesiveness and springiness values. The sensory scores in terms of flavour, body and texture, colour and appearance and overall acceptability were found to be significantly (P<0.05) decrease with progressive increase in storage period. The shelf life of *rava burfi* was found to be 9 days at room temperature (30±2 °C) and 35 days at refrigerated (7±2°C) temperature.

Keywords: Burfi, Cereal, *Khoa*, *Rava*, Semolina

INTRODUCTION

Burfi is one of the most popular *khoa* based sweet in India. Once confined to household production, *burfi* is gaining an international market in recent years owing to its delicious taste, flavour and texture. The most popular varieties of *burfi* are fruit, nut, chocolate, saffron and *rava burfi*. These ingredients can be used singly or in combination (Aneja *et al*., 2002).It is prepared from a mixture of *pindi khoa* and sugar, heating to near homogenous consistency. Beating and whipping operations prior to cooling are sometimes practiced to obtain a product with smooth texture and closely knit body. It is white to light cream in colour with firm body and smooth texture with very fine grains (Patil and Pal, 2005). *Khoa* has a unique adaptability in terms of flavour, body and texture to blend with a wide range of ingredients resulting in the development of a wide range of varieties of *burfi*. Several varieties of *burfi* are available in the market such as plain or *mawa*/*khoa burfi*, fruit and nut, cashew *burfi*, chocolate, saffron and *rava burfi* (Sachdeva and Rajorhia, 1982; Sarkar *et al.,* 2002). Cereals in milk are blended to compensate for deficiency of lysine in proteins. Cereals in combination with milk will make up the deficiency of protein quality of cereals. Cereals also constitute a source of calcium, iron and B vitamins (Millward *et al*., 2002). Moreover, at present the cost of semolina is about 1/12th that of milk solids.

Rava burfi is a heat desiccated sweetmeat prepared from a mixture of milk solids, *rava* (semolina) and sugar and sometimes garnished with nuts. At present there is no legal definition for *burfi* in India. However, BIS (IS:5550-1970) has mentioned requirements for different varieties of *burfi*. BIS has suggested standards for three types of *burfi* i.e. (a) milk or *mawa burfi*, (b) fruit, nut, chocolate or cocoa *burfi* and (c) *rava burfi* containing *khoa*, sugar and *rava* together with

flavouring and colouring material. Khan *et al.* (2008) studied the changes in quality of groundnut *burfi* packed in polypropylene (PP, 75 µ) and metallized polyester (12 µ) low density/linear low density (MP, 75 µ) during storage in order to assess the shelf life. The samples without sorbic acid spoiled within 30 days of storage due to mold growth and fermented odour. Groundnut *burfi* containing sorbic acid (0.3 per cent) did not support any microbial growth during storage of up to 8 months. Groundnut *burfi* remained stable and acceptable up to 6 months and 8 months under ambient temperatures (15-34 °C) in PP and MP pouches, respectively. Sachdeva and Rajorhia (1982) studied the chemical and microbiological changes in plain *burfi* during storage at room and refrigerated temperatures using two packaging materials viz., parchment paper and tin containers. The shelf life of *burfi* when stored in parchment paper was found 10 days at 30°C and 50 days at 5.0±1°C whereas *burfi* packed in tin containers had a shelf life of more than 105 days at 5.0±1°C.

Burfi with high moisture develops a hard structure and crystallization of sugar during long storage (Anon, 1979; 2012). The use of potassium sorbate @ 0.1 per cent followed by vacuum packaging preserved *burfi* samples in good conditions for more than 60 days (Patil and Pal, 2005). Vijayalakshmi *et al*. (2005) reported that a free O_2 absorber coupled with high – barrier materials like metalized films/foil laminates gave more than 45 days shelf life to *burfi* at 27 °C.

Shelf-life of *burfi* is most important from manufacturing and consumer point of view. To make *rava burfi* as commercially viable product, it should have sufficient shelf-life. The growth of the microorganisms brings about various changes in the product and spoils the taste of the product during storage. Hence the study was planned to evaluate the shelf life of *rava burfi* when stored at refrigeration and room temperatures.

MATERIALS AND METHODS

Standardized milk (4.6±0.2 % fat/ 8.6±0.05 % SNF) was used as the base material for preparation of *khoa*. *Rava* was procured from local market and the composition of *rava*. The product was analyzed for its proximate compositon and it was found to be 68.93 % carbohydrate, 0.2 % fat, 12.5 % protein, 0.8 % ash, 3.9 % crude fibre and 10.4 % moisture. Ghee of Amul Brand, Amul Dairy, Anand in Gujarat was used for roasting of *rava*. Cane sugar used was of commercial grade (M grade) which was obtained from the local market of Anand. Liquid glucose (Gujarat Ambuja Ltd., Ahmedabad) having a Dextrose Equivalent (DE) of 38-44 was procured used with 85.00±1.00 % TS, 4.8-5.2 pH, 1 (ml of NaOH 0.1 M) max. Free acidity, 38-44 DE and 0.25 % Ash max.

Analysis: Fat extraction of *khoa* and *burfi* were determined as per the procedure described in IS:2311 (1963). In this method, the sample is treated with ammonia to dissolve the proteins and ethyl alcohol to help precipitate the proteins. Thereafter, the fat is extracted with diethyl ether and petroleum ether. The mixed ethers are then evaporated and the residue weighed. Total nitrogen/protein of *khoa and burfi* was determined by Semi-Microkjeldahl method (IS:1479-Part-II, 1961). Ash content of all the samples was determined by procedure described in IS:1547 (1985). Lactose was derived by difference of sum total of the major constituents like moisture, protein, fat and ash from 100. Reducing and non-reducing sugars of *burfi* was determined by the volumetric method specified for ice-cream in IS:2802 (1964). The starch content of *burfi* was determined by the method given in ISI Handbook (1989). The crude fiber content of *burfi* was determined by the method given in IS:1155 (1968). The acidity of *burfi* was determined by method described in BIS (IS:1166-1968) for condensed milk. The pH of *burfi* was measured using Systronic digital pH meter, Model 335. The water activity of *burfi* samples, tempered at 25°C temperature, was measured using Rotronic Hygroskop Model: Hygrolab-3 (M/s. Rotronicag, Switzerland) connected to a sensing element (AW -DIO) with a measuring range of 0-100 % relative humidity (RH). The method prescribed by Deeth *et al.* (1975) was used to estimate the FFA content of *burfi*. The quantitative method presented by Keeney and Bassette (1959) for quantifying HMF by spectrophotometric measurement of the 2-thio barbituric acid (TBA) reaction product was used to assess the extent of browning in *burfi* samples with slight modification. The extent of oxidation of fat in *burfi* was measured in terms of TBA value. The extraction method of Strange *et al*. (1977) was followed with slight modification. TBA value was expressed as absorbance (OD) at 532 nm. The soluble nitrogen contents of *burfi* sample were determined by the procedure outlined by Kosikowaski (1982).

The moisture of semolina was determined by procedure described in IS: 1010 (1968). The protein content of semolina was determined by Kjeldahl method as described by AOAC (1970). The starch content of semolina was determined by the method given in ISI Handbook (1989) using 2 g sample. Total ash of semolina was determined by standard procedure given in IS:1010 (1968). The crude fiber of semolina was determined by the method given in ISI Handbook (1989) using 2 g sample.

Sensory evaluation: For the organoleptic evaluation of *burfi*, judges who were familiar with desirable attributes of *burfi* were selected. The selection criterion was that subjects had to be regular consumers of typical dairy sweets as well as their similar behavior between sensory evaluation sessions. The samples were subjected to sensory evaluation as described in using a 9 point hedonic scale score card as suggested by Stone

and Sidel (2004). The judges were also requested to note down their observations/comments for each attribute specified in the score card. The *burfi* samples were tempered at room temperature for 1-2 hour before judging. Sensory evaluation of the samples was conducted in isolated booths illuminated with incandescent light and maintained at 28±2 °C. Samples were served on SS dishes covered with polystyrene dish. The samples were labelled with three-digit codes. The order of presentation of the samples was randomized across subjects. The sensory panel (n=7) was composed of staff members and post graduate students working in the institution.

Texture profile analysis: Four samples of each experimental *burfi* were subjected to uniaxial compression to 80 % of the initial sample height, using a Food Texture Analyzer of Lloyd Instruments LRX Plus material testing machine, England; fitted with 0-500 kg load cell. The force-distance curve was obtained for a two-bite deformation cycle employing a Cross Head speed of 50 mm/min, Trigger 10 gf and 80 % Compression of the samples to determine various textural attributes of *burfi* held for 1 hour at 23±1 °C and 55 % relative humidity (RH).

Microbiological analysis: All the *burfi* samples were analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and Mold count (YMC) by the methods as described in IS:5550 (2005).

Statistical analysis: The mean value generated from the analysis of samples of *rava burfi*, obtained in three replications were subjected to statistical analysis using completely randomized design (CRD) as per Steel and Torrie (1980).

Preparation of *khoa* for manufacture of *rava burfi*: Standardized milk (4 % fat) was forewarmed (85 ° C/10 min) and pre concentrated to 50 % total solids in vacuum pan operated at 62 cm of Hg. *Khoa* was prepared from pre-concentrated milk by heat desiccation in a steam jacketed stainless steel open pan operated at 0.5 kg/cm^2 steam pressure with continuous manual stirring and scrapping. The process of heating stirring was continued till the product acquired desired consistency. The finished product was subsequently transferred to enamel trays, worked to pat form and packaged in sanitized polyethylene pouches. The samples were stored at room temperature (25 to 30 °C) for 18-20 hours.

Processing of *rava* for manufacture of *rava burfi:* Rava (small particle grade) (250 g) was spread uniformly on SS dish (1 cm thickness), covered with a SS lid, and autoclaved at 121 °C for 15 min. The contents were transferred to a thick bottomed SS karahi. The steamed *rava* was then roasted with 100 g ghee for 10 min at 140 °C till light brown colour was obtained.

Preparation of sugar syrup for manufacture of *rava burfi*: Weigh the desired amount of sucrose (190 g) and liquid glucose (36 g). Add 100 ml potable water. Boil the contents till the concentrate on reached 80 brix.

Preparation of *rava burfi*: *Rava burfi* was prepared according to the method standardized by Shrivas *et al.* (2015). *Khoa* (400 g) is blended with the processed *rava* and sugar syrup (boiling condition) and whipped well for 5 min. The contents are then poured on a greased tray and allowed to set overnight at room temperature. The contents are then cut into square pieces 3x3 cm. The *rava burfi* was packed in Composite polyethylene terephthalate (PET)/low density polyethylene (LDPE) film (50µ thickness) pouches and placed in PE box. The pouches were dipped in 0.5 per cent H_2O_2 solution and dried in an oven maintained at 60-65 °C for 30 min. Two hundred g of product was packed in each package.

The compositional, physico-chemical, rheological, sensory and microbial properties (SPC, coliform count and yeast and mould count) of fresh and stored samples of *rava burfi* were monitored at predetermined time interval, after every 3rd day for room temperature (30± 2 °C) and every 7th day for refrigerated temperature (7± 2 °C). Stored *rava burfi* was rejected on sensory basis as well as visible yeast and mould growth. This experiment was carried out in three replications. The results of replications on storage related changes in *rava burfi* are presented and discussed in this section.

RESULTS AND DISCUSSION

Effect of storage on composition of *rava burfi*: The storage changes taking place in the composition of *rava burfi* during storage at room and refrigerated temperature have been presented in Table 1and Table 2 respectively.

The values presented in Table 1 revealed that moisture content of *rava burfi* significantly (P<0.05) decreased from an initial moisture content of 19.29% to 17.53% during the storage period up to 9 days and thereafter

Table 1. Effect of storage period on composition of *rava burfi* at room temperature (30±2 °C).

Attribute (%)	Mean values of composition on storage for different periods in days				CD (0.05)
	0	3	6	9	
Moisture	19.29±0.41	18.75±0.26	18.16±0.24	17.53±0.24	0.40
Fat	18.40±0.01	18.52±0.029	18.65±0.029	18.76±0.038	0.05
Total protein	9.47±0.01	9.56±0.05	9.64±0.03	9.68±0.03	0.06
Ash	1.57±0.01	1.58±0.001	1.59±0.002	1.61±0.002	0.003
Added sugar	22.23±0.11	22.39±0.10	22.50±0.11	22.58±0.12	0.18
Lactose	10.43±0.04	10.50±0.01	10.58±0.02	10.64±0.02	0.03

Table 2. Effect of storage period on composition of *rava burfi* at refrigerated temperature (7±2°C).

Attribute (%)	Mean values of composition on storage for different periods in days						CD (0.05)
	0	7	14	21	28	35	
Moisture	19.29±0.41	18.46±0.37	17.88±0.50	17.44±0.50	16.77±0.75	16.22±0.85	1.04
Fat	18.40±0.01	18.60±0.02	18.73±0.02	18.86±0.02	19.03±0.03	19.25±0.05	0.05
Total protein	9.47±0.01	9.58±0.03	9.66±0.03	9.75±0.04	9.80±0.02	9.89±0.02	0.05
Ash	1.57±0.01	1.59±0.01	1.60±0.005	1.61±0.01	1.62±0.005	1.63±0.005	0.012
Added sugar	22.23±0.11	22.46±0.14	22.62±0.11	22.80±0.20	23.00±0.10	23.41±0.10	0.23
Lactose	10.43±0.04	10.54±0.03	10.63±0.03	10.70±0.03	10.79±0.04	10.89±0.02	0.05

Table 3. Effect of storage period on physico-chemical properties of *ravaburfi* at room temperature (30±2 °C).

Attribute	Mean values of physico-chemical properties on storage for different periods in days				CD (0.05)
	0	3	6	9	
Acidity (% LA)	0.264±0.001	0.275±0.001	0.285±0.001	0.294±0.002	0.002
Water activity	0.813±0.001	0.796±0.002	0.750±0.001	0.740±0.002	0.002
Free Fatty Acid (FFA) (µ eq/g)	0.63±0.01	0.69±0.01	0.72±0.01	0.75±0.01	0.015
Soluble Nitrogen (%)	0.11±0.001	0.13±0.01	0.17±0.01	0.20±0.01	0.015
5-Hydroxy Methyl Furfural (HMF) (µ moles / 100g)	27.29±0.03	33.79±0.02	40.51±0.03	46.09±0.04	0.05
TBA (OD)	0.083±0.002	0.090±0.003	0.10±0.002	0.17±0.004	0.004

Table 4. Effect of storage period on physico-chemical properties of *ravaburfi* at refrigerated temperature (7±2 °C).

Attribute	Mean values of physico-chemical properties on storage for different periods in days						CD (0.05)
	0	7	14	21	28	35	
Acidity (% LA)	0.264±0.001	0.271±0.001	0.276±0.001	0.281±0.002	0.287±0.002	0.293±0.001	0.003
Water activity	0.813±0.001	0.791±0.001	0.783±0.001	0.769±0.001	0.755±0.001	0.743±0.001	0.002
Free Fatty Acid (FFA) (µ eq/g)	0.63±0.001	0.634±0.001	0.637±0.001	0.639±0.001	0.642±0.01	0.646±0.003	0.002
Soluble Nitrogen (%)	0.11±0.001	0.15±0.006	0.18±0.006	0.20±0.01	0.23±0.01	0.30±0.01	0.015
5-Hydroxy Methyl Furfural (HMF)(µ moles / 100g)	27.29±0.03	30.53±0.04	33.60±0.03	36.20±0.04	39.60±0.06	43.14±0.05	0.07
TBA	0.083±0.002	0.089±0.001	0.095±0.001	0.10±0.02	0.15±0.01	0.23±0.03	0.025

Table 5. Effect of storage period on rheological properties of *rava burfi* at room temperature (30±2°C).

Attributes	Mean values of rheological properties on storage for different periods in days				CD (0.05)
	0	3	6	9	
Hardness (N)	19.71±0.10	23.21±0.10	27.26±0.10	31.28±0.10	0.15
Cohesiveness	0.0027±0.0001	0.0024±0.0002	0.0021±0.0002	0.0018±0.0002	0.0001
Gumminess (N)	0.30±0.01	0.52±0.01	0.62±0.01	0.71±0.01	0.015
Chewiness (N mm)	2.02±0.10	2.32±0.10	2.62±0.10	2.92±0.10	0.13
Adhesiveness (N mm)	1.10±0.004	1.63±0.04	2.32±0.03	2.84±0.03	0.04
Springiness (mm)	1.27±0.01	1.15±0.01	1.09±0.01	1.03±0.01	0.013

the product was unacceptable due to visible mould growth. It can be seen that there was a progressive decrease in the moisture content of the product when stored at refrigerated temperature (Table 2) also. This effect was found to be significant ($P<0.05$). After 35th day of storage at refrigeration temperature the product was unacceptable due to textural changes in the product. During storage period, the moisture content of *rava burfi* decreased rapidly at room temperature as compared to refrigerated temperature. As the storage period progresses, the sample showed an increase in the fat content for both the storage temperatures studied. There was a progressive increase in protein content with increase in storage period at 30±2 °C, which was found to be significant ($P<0.05$). A similar trend was found when the product was stored at 7±2 °C. A significant ($P<0.05$) increase in lactose, sucrose (added sugar) and ash content with increase in storage period for both the temperatures studies was also observed. The decrease in moisture content during refrigerated storage might be due to drying at low temperature (7±2°C) and surface evaporation (Sharma *et al*., 2003). Sachdeva and Rajorhia (1982) and Bhatele (1983) also reported decrease of moisture content during storage of *burfi*at 30±2 °Cand 7±2 °C. The increase in protein, fat, lactose, sucrose and ash contents could be attributed to the decrease in moisture content with increase in storage period. Thus, moisture loss during storage with progressive increase in content of other constituents viz. fat, protein, ash, sucrose (added sugar) andlactose either at room temperature or refrigeration temperature is a natural phenomenon as reported by several workers and this is evident in this study also.

Effect of storage on physico-chemical properties of *rava burfi*: The result of storage period on acidity, water activity, Free Fatty Acid (FFA), soluble nitrogen, 5-Hydroxy Methyl Furfural (HMF) and Thiobarbituric Acid (TBA) content of *rava burfi* stored at room and refrigerated temperatures are presented in Tables 3 and 4 respectively.

Table 6. Effect of storage period on rheological properties of *rava burfi* at refrigerated temperature (7±2°C).

Attributes	Mean values of rheological properties on storage for different periods in days						CD
	0	7	14	21	28	35	(0.05)
Hardness (N)	19.71±0.10	21.82±0.10	23.84±0.10	25.65±0.10	27.55±0.10	29.67±0.1	0.18
Cohesiveness	0.0027±0.0001	0.0025±0.0001	0.0022±0.0001	0.0020±0.0001	0.0018±0.0001	0.0014±0.0001	0.0002
Gumminess (N)	0.30±0.01	0.50±0.02	0.70±0.02	0.90±0.02	1.20±0.02	1.50±0.02	0.03
Chewiness (Nmm)	2.02±0.10	2.17±0.10	2.38±0.10	2.56±0.10	2.63±0.10	2.86±0.1	0.18
Adhesiveness (N mm)	1.10±0.004	1.56±0.1	2.23±0.1	2.71±0.1	3.25±0.05	3.76±0.02	0.13
Springiness (mm)	1.27±0.01	1.19±0.01	1.16±0.01	1.09±0.01	1.04±0.01	0.99±0.01	0.02

Table 7. Effect of storage period on sensory properties of *ravaburfi* at room temperature (30±2°C).

Attributes	Mean values of sensory properties on storage for different periods in days				CD
	0	3	6	9	(0.05)
Flavour	8.22±0.20	8.23±0.10	7.73±0.10	6.98±0.10	0.15
Body and texture	8.16±0.15	7.78±0.10	7.48±0.10	6.53±0.10	0.15
Colour and appearance	8.44±0.10	8.23±0.10	7.73±0.10	6.98±0.10	0.15
Overall acceptability	8.48±0.06	7.83±0.10	7.48±0.10	7.02±0.10	0.15

Table 8. Effect of storage period on sensory properties of *ravaburfi* at refrigerated temperature (7±2°C).

Attributes	Mean values of sensory properties on storage for different periods in days						CD
	0	7	14	21	28	35	(0.05)
Flavour	8.22±0.20	7.87±0.21	7.40±0.10	6.90±0.10	6.60±0.20	6.20±0.20	0.31
Body and texture	8.16±0.15	8.03±0.06	7.77±0.25	7.43±0.21	7.23±0.25	6.45±0.02	0.32
Colour and appearance	8.44±0.10	8.13±0.15	8.00±0.20	7.80±0.20	7.67±0.15	6.77±0.25	0.32
Overall acceptability	8.48±0.06	8.13±0.15	8.00±0.20	7.80±0.20	7.67±0.15	6.20±0.20	0.30

Table 9. Effect of storage period on microbial quality of *ravaburfi* at room temperature (30±2°C).

Attributes	Mean values of microbial counts for different periods in days				CD
	0	3	6	9	(0.05)
SPC, log cfu/g	3.78±0.01	3.81±0.01	3.83±0.01	3.88±0.02	0.017
Yeast and mould counts, cfu/g	Nil	Nil	1.38±0.02	1.42±0.03	-
Coliform counts, cfu/g	Nil	Nil	Nil	Nil	-

Table 10. Effect of storage period on microbial quality of *ravaburfi* at refrigerated temperature (7±2°C).

Attributes	Mean values of microbial counts for different periods in days						CD
	0	7	14	21	28	35	(0.05)
SPC, log cfu/g	3.78±0.01	3.80±0.01	4.06±0.12	4.25±0.01	4.41±0.02	4.62±0.02	0.10
Yeast and mould counts, log cfu/g	Nil	Nil	Nil	1.95±0.01	2.20±0.02	2.48±0.12	-
Coliform counts, cfu/g	Nil	Nil	Nil	Nil	Nil	Nil	-

It can be seen that the acidity of *rava burfi* was significantly influenced by storage period when stored at room temperature (Table 3). Similar results were also observed when the product was stored at refrigerated temperatures (Table 4). During storage of *rava burfi* at refrigerated temperature a significant ($P<0.05$) increase in acidity content from 0.264±0.001% LA at 0^{th}day to 0.293±0.001% LA at 35^{th} day was observed. It can be seen that the titratable acidity of *rava burfi* increased at faster rate during storage period at room temperature as compared to refrigerated temperature. The acidity development could be attributed to production of acids like formic acid, acetic acid, lactic acids and other organic acids and FFA as reported by O' Brien (1997). Maillard reaction also produces many organic acids which are also responsible for increase in acidity (Goyal and Shrinivasan, 1988; 1989). Similar findings were reported by Sachdeva and Rajorhia (1982) in *burfi* during storage. Increase in titratable acidity was also observed during storage of *khoa* (Kalra *et al*., 1973). Thus the results obtained in the present investigations corroborates with those reported in literature.

Water activity is defined as the vapor pressure of water in the product divided by that of pure water at the same temperature. Higher a_w substances tend to support more microorganisms. Bacteria usually require at least 0.91, and fungi at least 0.7 a_w for their growth. Bacterial growth potential can be correlated with moisture in the product concerned. Thus, water activity is helpful in deciding the shelf life of the product either by support or otherwise to the bacterial growth or change in the textural properties due to water transfer. The mean water activity values presented in Table 3 and 4 reveal that water activity of *rava burfi* was significantly ($P<0.05$) reduced during the storage period from 0.813±0.001 at 0^{th}day to 0.740±0.002 at 9^{th} day of storage at room temperature. As observed from the Table 3 and Table 4, the water activity of *rava burfi* decreased during storage period at both room temperature as well as refrigerated temperature. This decrease in water activity could be attributed to decrease in moisture of the *rava burfi* during storage. A similar trend in reduction of water activity of *burfi* during storage was also reported by Tiwari (2013). Londhe *et*

al. (2012) also reported decrease in water activity of brown *Peda* during storage at 30±2 °C using different packaging techniques.

Lipolysis, regardless of cause seriously degrades the quality of the stored product by imparting off flavours and is also responsible for the development of rancidity. In stored dairy products, lipolysis by microbial lipase is of the greatest significance (Murphy and Downey, 1970;Law, 1979). The influence of storage period on FFA content of *rava burfi* stored at room temperature as shown in Table 3 reveals that the mean FFA value of *rava burfi* was found significantly affected by the storage period. During storage of *rava burfi*, a significant increase in FFA content upto 9th day was observed and thereafter the product was found unacceptable due to visible mould growth. This increase in FFA content may be due to the higher SPC and Yeast and mould counts observed at higher temperatures as is evident in Table 9 and Table 10. This increase in FFA content could be attributed to hydrolysis of fat which is primarily affected by the growth of yeasts and molds. In the present investigation also the increase in FFA could be due to increase in yeast and mold count. A similar trend of increase in FFA content during storage was noticed in *burfi* by Tiwari (2013). Vijaykhder and Patel (1983) also reported an increase in free fatty acids in *Peda* during storage at ambient temperature (25-29ºC), using polyethylene bags of various densities.

Soluble nitrogen is the measure of water soluble nitrogenous portion of protein. This may result from the degradation of proteins because of proteolysis and hence it serves as an important constituent for monitoring the proteolysis in fermented milk products like chesses. In heat desiccated products such as *burfi*, it may serve as an indicator of storage related deterioration of milk proteins and some minor solubilization of micellar proteins due to vigorous heat and agitation employed in the process of manufacture of *burfi*.Tabulated values revealed that the soluble nitrogen of *rava burfi* samples (Table 3) stored at room temperature was significantly (P<0.05) affected by storage period. As the storage period advanced, soluble nitrogen increased in *rava burfi*. It can be seen that soluble nitrogen content of fresh *rava burfi* was significantly (P<0.05) increased from 0.11±0.001% at 0th-dayto 0.20±0.01%at the 9th day of storage at ambient temperature. At refrigerated temperature of storage a similar significant increase in soluble nitrogen was also observed although at lower rate as seen in Table 4. The higher soluble nitrogen content observed could be attributed to the heat treatment employed. The phenomenon of the heat treatment on degradative changes in protein is well established (Jenness and Patton, 1969). On the other hand survival of heat resistant groups of bacteria and heat stable enzymes capable of protein breakdown could be also considered for proportionately higher soluble nitrogen content during storage. The increase in soluble nitrogen content on storage might be the direct consequence of degradation of protein content of *rava burfi*.

The determination of HMF in *burfi* was done to measure the extent of browning changes during storage. The values presented in the table reveal that the HMF content of *rava burfi* significantly (P<0.05) increase with increase in storage period at both the temperatures. At refrigerated temperature (7±2 °C), the HMF content of *rava burfi* increased significantly (P<0.05) from 27.29±0.02 µ moles / 100gat 0th dayto 43.14±0.05 µ moles / 100gat 35th day of storage period. The increased in HMF content in heat treated milk products is an usual phenomenon but could be restricted by controlling factors such as temperature, storage period and certain specific characteristics of the product viz. pH, TS, a_w etc. (Walstra and Jenness, 1984). The results obtained in present study are in agreement with the results reported by Patil and Pal (2005) and Sachdeva and Rajorhia (1982) in *burfi*.

TBA determination is one of several analytical methods for the evaluation of the degree of oxidation of oils and fats. 2-thiobarbituric acid forms red-coloured products with malonaldehyde, some polyunsaturated aldehydes, dioxolanes and furan derivatives. The intensity of colouration is correlated with the rancidity degree of fats and oils.It can be revealed from the Table 3 TBA content of fresh *rava burfi* was significantly (P<0.05) increased during storage of *rava burfi* from 0.083±0.002 O.D. (Optical Density) at 532 nm at 0th-day to 0.17±0.004 O.D. at 9th day at 532 nm at room temperature. At refrigerated temperature the TBA content of *rava burfi* significantly increased during the storage period at up to 35th day of storage. Thus, it can be concluded that the TBA values of *rava burfi* during storage period increased more rapidly at room temperature than at refrigeration temperature. The increase in TBA values might be due to oxidation of milk fat and ghee used for roasting of *rava* of *rava burfi*during storage. Increase in TBA values during storage were also noticed by Sachdeva and Rajorhia (1982) in *burfi*.

Effect of storage on rheological properties of *rava burfi*: Textural attributes like hardness, cohesiveness, gumminess, chewiness, adhesiveness and springiness, and were analyzed during the storage period. The changes taking place in the textural profile of *rava burfi* during storage at room and refrigerated temperature are presented in Tables 5 and Table6 respectively.

It can be seen from the Table 5 that the hardness of *rava burfi* was significantly (P<0.05) increased during the storage period at room temperature from 19.71±0.10 N at 0th day to 31.28±0.10 N at 9thday of storage. The effect of storage period at refrigerated temperature (7±2 °C) on the hardness of *rava burfi* is depicted in Table 6. The increase in hardness of samples of *rava burfi* during storage could be attributed to

the decrease in moisture content in *rava burfi* (Table 1 and Table 2). Similar findings were reported by Bhatele (1983) and Tiwari (2013) during storage of *burfi*. During the storage at room and refrigerated temperatures (Table 5 and Table 6 respectively) the cohesiveness and springiness of *rava burfi* was significantly ($P<0.05$) decreased. The decrease in cohesiveness and springiness might be due to decrease in moisture content on storage resulting into less cohesion of the matrix of the *rava burfi*. The mean values presented in the Tables 5 and Table 6 show that gumminess, chewiness and adhesiveness values of *rava burfi* was found to be significantly increased during storage. Tiwari (2013) also reported increase in chewiness during storage of *burfi*. The increase in chewiness values of *rava burfi* during storage may be due to increase in hardness values resulting from moisture loss as can be seen from earlier tables for moisture and hardness. Londhe *et al*. (2012) also reported increase in chewiness value of brown *Peda* during storage at 30±2 °C irrespective of different packaging techniques used. The results obtained in this study are not in agreement with those obtained by Chawla *et al.* (2013) who reported that textural attributes like adhesiveness, springiness and gumminess of *doda burfi,* (a similar product which is a *burfi* prepared from milk solids and germinated wheat flour) showed a significant decreasing trend for storage intervals whereas hardness, chewiness and cohesiveness showed a significant increasing trend in products stored at both ambient (30±2°C) refrigerated temperature (7±2°C).

Thus, based on the observations from storage products at both the storage temperatures, it can be said that moisture loss during storage mainly affects the textural changes i.e. the inner makeup of the products. These changes have played a major role in deciding the acceptability of stored products, particularly at refrigerated temperature.

Effect of storage on sensory properties of *rava burfi*: The sensory attributes have profound effect on the consumer's preference. Different food products undergo deterioration in sensory profile as a consequence of various chemical and biochemical changes that progress during storage. The effect of storage period on sensory attributes of *rava burfi* stored at room temperature is presented in Table 7.

The mean value presented revealed that flavour score of *rava burfi* was significantly ($P<0.05$) reduced during the storage period. During storage of *rava burfi*, flavour score up to 9th day was observed and thereafter the product became unacceptable due to visible mould growth. From the Table 7 and Table 8 it can be seen that the flavour score decreased rapidly at room temperature as compared to refrigerated temperature during storage. The decrease in flavour score could be attributed to slight loss of freshness, which is inherent with any food product.

In fresh product, the compounds formed during browning reactions are responsible for the typical flavour of the product, but as storage period progresses, the chemical reactions disturbed the delicate balance of the compounds. The findings of the present study are in accordance with the result reported by Biradar *et al*. (1985) and Londhe *et al*. (2012) for brown *peda* andSharma *et al*. (2003) in *Malai Peda* samples during storage study. Similar observations were recorded on stored *kalakand* by Rao and Goyal (2007) and stored *doda burfi* by Chawla *et al.* (2013).

It can be seen from Table 7 that body and texture score of *rava burfi* was significantly ($P<0.05$) influenced by the storage period at room temperature (30±2 °C). During storage of *rava burfi* the body and texture score decreased significantly from 8.16±0.15 at 0th day to 6.53±0.10 at the 9th day of storage. Similarly, at the refrigerated temperature, the body and texture score of *rava burfi* was found significantly ($P<0.05$) decreased during storage period Table 8. The initial mean body and texture score of 8.16±0.15 at 0thday decreased to 6.45±0.02 at 35th day of storage as per Table 8.The decrease in body and texture score of samples was observed in both the samples kept at different temperatures and it was much faster in the product kept at 30±2 °C compared to the samples kept at lower temperatures (i.e. 7±2 °C). A similar decrease in body and texture scores were observed in *multigrain halwa* samples kept at ambient and refrigerated conditions of storage (Itagi *et al.,* 2011).

Like chemical changes, textural changes also continue during storage in *rava burfi*. At room temperature the integrity of the grains remained intact, but the grains became harder and chewier becoming conspicuous in the product as the moisture content reduces. At refrigerated temperature the product became dry, hard, sandy and brittle which might be ascribed to the loss of moisture and possible due to crystallization of added sugar. This is because of dynamic structural and conformational changes, which may or may not be dependent on changes in moisture content(Navajeevan and Rao, 2005) and can be attributed to decline in hydrophilic groups. Therefore, body and texture was considered as important criteria for determining the acceptability of *rava burfi* during storage study particularly at refrigerated temperature (7±2 °C). The values of these parameters are also supported by the textural parameters such as hardness, cohesiveness and others.

The mean values presented reveals that colour and appearance score of *rava burfi* was significantly ($P<0.05$) decreased during the storage period. During storage of *rava burfi* at room temperature, decreased in colour and appearance score from 8.44±0.10 at 0th day to 6.98±0.10 at the 9th day of storage was observed. From the Table 7 and Table 8it can be observed that the changes in colour and appearance scores decreased rapidly at room temperature than at refrigeration tem-

perature. The decline in scores during storage of *rava burfi* can be attributed to microbial, chemical and textural changes in the product. During storage the samples became drier in appearance and lacked the greasy appearance desired in good quality *burfi* which resulted in a steady decrease in colour and appearance scores. The colour and appearance of the product became dull and darker with dry appearance. Moreover in the present study, evaporation of moisture during storage might have aggravated the appearance of the *rava burfi* as presence of moisture enlivens the appearance of the product by reflecting incident light. Londhe *et al*., (2012) reported decrease in colour and appearance score during storage study of brown *Peda* at 30±2 ºC using different packaging materials. These results are in accordance with those observed by Chawla *et al.* (2013) who also noted a decrease in colour and appearance scores of *doda burfi* on storage.

The overall acceptability of stored samples depends upon several factors like degree of proteolysis, extent of lipolysis, flavour changes and microbial activity. Statistical analysis indicated a significant ($P<0.05$) difference among the treatment, viz. type of *burfi* and storage period for both the temperatures studied viz. 30±2 °C and 7±2 °C.As observed from the Table7 and Table 8the overall acceptability score decreased rapidly at room temperature compared to refrigeration temperature. The decline in overall acceptability scores of *rava burfi* was due to changes in flavour and body and texture characteristics. The influence of storage period and temperature of storage was significant for changes in flavour and body and texture and thus, overall acceptability scores. All deteriorative changes, i.e. oxidative, proteolytic, lipolytic, browning, acid development, microbial and textural changes were collectively reflected in sensory quality and thus led to unacceptability of the stored product after a definite period. Low temperature always promotes a longer shelf life of many products and the same was confirmed in this study. This could be attributed to the lower rate of lipid oxidation and non-enzymatic browning reactions which decreases the shelf life of products stored at elevated temperatures (Rossini *et al*., 2011). Similar effect was found in *rava burfi*, where the rate of reaction appeared to be very fast at 30±2 °C whereas, the same product had a shelf life of 35 day without any sign of spoilage at lower temperature. Hence, the results corroborates with the present finding of this research.

Effect of storage on microbial quality of *rava burfi*:

Most of the milk products are perishable commodities. The perishability of milk products is mostly ruled by microbiological quality of that product. According to BIS (IS:5550:2005) standards laid down for Burfi, the standard plate count should not be more than 30,000/g and the yeast and mould count not more than 10/g burfi. The microbial count influences the acceptability and hence, shelf life of any product affecting its colour and appearance, flavour and body and texture of the product. The shelf life of product like *rava burfi* depends on the growth of microorganisms in the product during storage. Most of the physico-chemical changes as like FFA content, soluble nitrogen, acidity development, change in pH etc., are affected by the presence and growth of various microorganisms. Increase in FFA and soluble content signifies lipolytic and proteolytic activity caused by microorganisms. Therefore the stored samples of *rava burfi* were subjected to microbiological analysis for standard plate count (SPC), yeast and mold count (YMC) and coliform count. The influence of period of storage at room temperature (30±2 ° C) on the SPC of *rava burfi* stored at ambient temperature is presented in Table 9. The mean value presented reveals that SPC of *rava burfi* was significantly ($P\leq0.05$) influenced by storage period. During storage of *rava burfi*, significant ($P\leq0.05$) increase in SPC in both of the packages up to 9^{th}day was observed thereafter the product was found unacceptable due to visible mold growth. The initial mean SPC of 3.78±0.01 log-cfu/g at 0^{th}day increased to 3.88±0.02 log cfu/g at the 9^{th} day of storage. During storage of *rava burfi* at refrigerated temperature also, a significant ($P\leq0.05$) increase in SPC up to 35^{th}day was observed and thereafter the product was found unacceptable due to visible mold growth. From the table it can be seen that the SPC increases rapidly at room temperature compared to refrigeration temperature during storage period. Sachdeva and Rajorhia (1982) reported increase in SPC during storage of *Burfi* at 30±2 °C and 7±2 °C. Other workers also reported increasing standard plate counts of *Burfi* during storage (Garg and Mandokhot, 1984; Misra and Kuila, 1988; Sachdeva and Rajorhia, 1982).

For most of the intermediate moisture Indian dairy foods such as *Peda*, *Burfi*, *Kalakand,* etc. mould growth tends to be a major problem and often most important single factor limiting their shelf life.The influence of period of storage at room temperature (30±2°C) on the yeast and mold count of *rava burfi* is presented in Table 9. The mean values presented reveals that Yeast and mould count of *rava burfi* was found nil up to 3^{rd} day of storage. During further storage of *rava burfi*, increase in yeast and mold count up to 9^{th}day was observed and thereafter the product was found unacceptable due to visible mold growth. The influence of period of storage at refrigeration temperature (7±2°C) on the yeast and mold count of *rava burfi* is presented in Table 10. The mean values presented reveals that yeast and mould count of *rava burfi* was found nil up to 14^{th} day of storage. During further storage of *rava burfi*, increase in yeast and mold count up to 35^{th} day was observed and thereafter the product was found unacceptable due to visible mold growth. From the Table 9 and Table 10 it can be seen that the yeast

and mold count increased rapidly with storage period at room temperature compared to refrigerated temperature. The colonies obtained in the present study at room temperature storage were white and green colonies. The numbers of the fungal colonies obtained during present investigation are similar to various workers who had analyzed the milk products like *Pedha, Burfi* and *Kalakand* (Biradar *et al*. 1985, Dwarkanath and Srikanta 1977). Sachdeva and Rajorhia (1982) reported increase in yeast and mold count during storage of *Burfi* at 30±2 °C and 7±2 °C. The product was found to be free from coliforms and during storage there was no coliform count as presented in Table 9 and Table 10.

Conclusion

Based on the results obtained in the present study it can be concluded that the shelf life of *rava burfi* was found to be 9 days at room temperature (30±2 °C) and 35 days at refrigerated (7±2°C) temperature when packed in composite polyethylene terephthalate (PET)/ low density polyethylene (LDPE) film. During storage period there was a decrease in moisture content and water activity and an increase in fat, protein, lactose, ash, added sugar, acidity, FFA, soluble nitrogen, TBA and HMF both at ambient (30±2 °C) as well as at refrigerated (7±2°C) temperature.

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